

TITLE: Tropical Pacific Moisture Variability

INVESTIGATORS : James P. McGuirk
Department of Meteorology
Texas A&M University
College Station, TX 77843-3146
(409) 845-4431

RESEARCH OBJECTIVES:

1. To describe the synoptic scale variability of moisture over the tropical Pacific Ocean.
2. To describe the systems leading to this variability.
3. To develop and implement satellite analysis procedures to facilitate (1) and (2) over the data sparse Pacific.

SIGNIFICANT ACCOMPLISHMENTS IN FY-87/88:

1. Radiative transfer model (RTM) based efforts. The NASA GLA RTM has been modified for operationally oriented research at TAMU. Significant results from the use of this tool are:
 - a. The disparity between TIROS- and radiosonde-observed moisture has been identified as a tropopause level contamination by meteorologically insignificant moisture. The sensitivity of TIROS moisture channels to observed and hypothetical moisture profiles has been mapped.
 - b. Vertical synoptic structure is being identified and quantified using a synthetic data base generated through the RTM. Several data sets, based on fictitious and actual conditions, have been analyzed and statistical tools have been developed which objectively classify a sounding type and quantify its features. The procedure can be implemented independently from operational retrieval methodologies. Clustering and classification techniques are used to sort synthetic "observations" into specified sounding classes; the variance structure within the sounding class can then be used to infer features, like inversion strength and height.
 - c. Calculations have been set up to generate synthetic TIROS N channel radiance maps from ECMWF (and other) operational analyses.
2. Outgoing longwave radiation (OLR) based studies. This research extends OLR capability to synoptic scale systems, an application not well studied:
 - a. Disturbances generated by east Asian cold surges have been tracked across the Pacific and their evolution and characteristics in OLR data and operational analyses described. Why these systems normally are not found in the east Pacific is hypothesized. The relationship between cold surge phenomena and moisture bursts is clarified--the former triggers over 40% of the latter.
 - b. Large synoptic scale variations of the Pacific ITCZ are documented over an 8-yr OLR record. Local ITCZ activity possesses large meridional scales. Systematic ITCZ variations are described; for example, ITCZ intensification is related to a southward displacement of convection.

3. Observational tropical TIROS-N radiance data. Studies extending the interpretations of satellite observations continue:

a. Complete statistical properties of satellite radiance fields are not well known. Horizontally and vertically oriented statistical structure differs strongly between satellite observations and model analyses. The "temperature", "moisture" and "lapse rate" eigenfunctions of TIROS data are not reproduced in ECMWF eigenfunctions. Similar disparity exists in horizontal structure functions. These structure functions contain information not being utilized currently.

b. Satellite moisture observations have been documented further. They possess a bimodal character, with a small portion of exceedingly dry tropical observations linked unambiguously to moisture bursts; these systems provide significant dry air to the mid-tropospheric tropics. EOF and filtered individual channel radiance fields describe a typical equatorial wave associated with developing moisture bursts. The signal is subtle, but repeatable, and requires careful compositing of events; results are consistent with OLR and VAS water vapor composites and provide new horizontal and vertical system structure.

4. Dynamics of moisture bursts. Study of dynamical mechanisms has been curtailed due to funding. Both moisture and momentum budgets of tropical analysis contain unacceptably large errors. For moisture, not even the right sign on the local change can be computed reliably, even using available radiosonde data. For momentum, subjective analyses which better fits observations provide more physically interpretable balances; uncertainties have important consequences regarding moisture burst and subtropical jet development.

FOCUS OF CURRENT RESEARCH AND PLANS FOR FY 88/89:

The following tasks will be initiated or continued this year:

1. Continue a recently initiated moisture burst case study utilizing SMMR microwave moisture and precipitation data.
2. Conclude the RTM-based development of a technique to specify synoptic features in tropical soundings. Explore applications with real data.
3. Conclude a comparative study of horizontal and vertical structure of TIROS and ECMWF analysis data. Included in this study will be new analysis of synthetic satellite data (generated from ECMWF analysis and the RTM). Quantification of the sensitivity of analysis procedures and clouds on resultant analysis and satellite data is the goal.
4. Initiate a study to relate tropical moisture fields to wind fields. Even if moisture analysis in the tropics is perfected, if it is not consistent with the wind fields, model integrations quickly destroy the accuracy of the moisture analysis.
5. Intensify documentation efforts. A number of studies or been completed and are not yet published. A major effort will be expended to rectify this situation.

PUBLICATIONS:

Refereed:

McGuirk, J. P., A. H. Thompson and L. L. Anderson, 1988: Synoptic scale moisture variation over the tropical Pacific Ocean. Accepted for Mon. Wea. Rev.

_____, _____, and J. R. Schaefer, 1988: An eastern Pacific tropical plume. Accepted for Mon. Wea. Rev.

Conference Proceedings:

Blackwell, K. G., J. P. McGuirk and A. H. Thompson, 1988: Temporal and spatial variability and contamination in 6.7 and 7.3 micrometer water vapor radiance data, *op. cit.*

Thompson, A. H., J. P. McGuirk and D. J. Ulsh, 1988: Tropical synoptic signatures in composited 6.7 micrometer water vapor imagery, Third Conf. on Satellite Meteorology and Oceanography, AMS, Feb., 1988, Anaheim.

White III, G. A., J. P. McGuirk and A. H. Thompson, 1988: Identification and recovery of discontinuous synoptic features in satellite-retrieved soundings using a radiative transfer model, *op. cit.*

McGuirk, J. P., 1987: Climatology of various synoptic systems over the tropical North Pacific, 12th Climate Diagnostics Workshop, Salt Lake City, Oct., 1987.

_____, and A. H. Thompson, 1987: Tropical synoptic scale momentum budgets during FGGE SOP 1, 19th IUGG General Assembly, Vancouver, Aug. 1987.

Thompson, A. H., J. P. McGuirk and K. G. Blackwell, 1987: Synoptic scale moisture transports using ECMWF analysis and satellite data, *op. cit.*

White III, G. A., and J. P. McGuirk, 1987: Canonical discriminant analysis of synoptic signatures in satellite channel brightness temperature data, Tenth Conf. on Probability and Statistics in Atmospheric Science, Edmonton, October, 1987.

Theses:

Blackwell, K. G., 1987: Synoptic scale sensitivity of TIROS-N moisture channels in the tropics. Master's Thesis, Texas A&M University, 125 pp.

Ulsh, D. J., 1988: Moisture burst structure in satellite water vapor imagery. Master's Thesis, Texas A&M University, 101 pp.

Hayes, P. M., 1988: Active modes of the Pacific ITCZ. Master's Thesis, Texas A&M University, 90 pp.

Sautter, D. C., Synoptic-scale east Asian cold surge-induced phenomena. Master's Thesis, Texas A&M University, 104 pp.

[Totalling 4 refereed publications, 20 conference papers, 9 M.S. theses, and 1PhD. dissertation under 5 yrs. of NASA sponsorship, commencing April 1983]

